REAL-TIME HYDROLOGIC DATA COLLECTION SYSTEMS FOR THE SOUTHEAST

Bradley L. Gimmestad

AUTHORS: Flash Flood Hydrologist, National Weather Service, Southeast River Forecast Center, 1001 International Boulevard, Atlanta, GA 30354.
REFERENCE: Proceedings of the 1989 Georgia Water Resources Conference, held May 16 and 17, 1989, at The University of Georgia. Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia, 1989.

INTRODUCTION

One of the principle non-structural methodologies for mitigating flood damages is through an effective flood warning system. Throughout much of the country, extensive development in, adjacent to, and upstream of numerous flood plains has greatly increased the potential for property damage and loss of life. As property values and population pressures have increased, the use of many structural techniques for flood control have become limited by excessive costs. As a consequence there is now a growing interest in non-structural flood protection methods.

METHOD

Approximately 10 years ago the National Weather Service (NWS) developed an automated data collection and warning system called ALERT (Automated Local Evaluation in Real Time). ALERT makes available to local officials the information required to evaluate the immediate flood potential from rainfall which has already occurred and assists in evaluating the effects on this potential from additional rain which may occur within the next few hours.

The key factor is "real-time". A truly real-time system is a system which is as current as each breath we take. Any system which takes longer than that has built in "dead time". This "dead time" may be from time-consuming interrogated or manual data systems, obsolete hydrologic analysis procedures, or systems without automatic warning for reported or forecast conditions. Real-time means NOW, not in five or ten minutes, but now. This will give a maximum effective flood warning lead time, allowing local officials to make decisions on flood response and emergency plans.

This system is appropriate for many of the 20,000 communities that the Federal Emergency Management Agency (FEMA) has identified with flash flood problems. It is a means of providing flood alerting through local cooperation which otherwise could overwhelm NWS resources. Many of the flood prone communities are located on small, flashy streams which, following the occurrence of heavy rainfall, may crest in a period ranging from a few hours down to less than one hour. Very little lead time is available in these situations to warn residents. The NWS is presently unable to provide warning service to these vulnerable communities because of the scarcity of hydrologic data in these river basins and because floods occur in such short time periods.

ALERT focuses on the local cooperating agency or community as the keystone of the flood warning program. The system is locally owned and operated. All local data in ALERT systems flow immediately to the local cooperator, and the evaluation of risk is its discretion.

ALERT systems consist of automated event-reporting river and precipitation gages, automated data collection and processing equipment, a hydrologic model, hydro-meteorological analysis, and processing software, as well as communications and display software. Data transfer is usually done by VHF line-of-sight radio transmission, although telephone and satellite communications have been used (Figure 1).

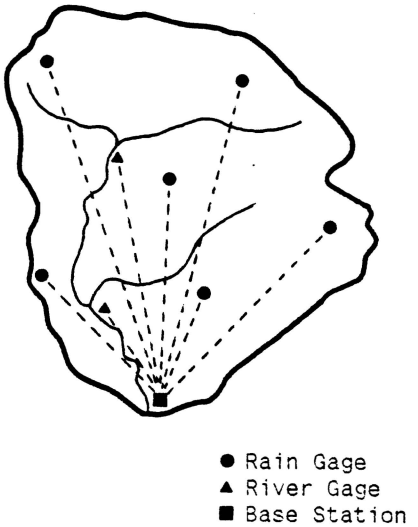

Figure 1. Example of ALERT Reporting Network

ALERT Equipment

The precipitation gages in ALERT systems are modular, self-contained, self-powered, event reporting units (see Figure 2). The structural component of the gage is fabricated from a 12-inch aluminum pipe of sufficient length to provide a buried well for shielding on-site electronics and stabilizing the battery and raising the orifice to a level which discourages vandalism and minimizes seasonal vegetation effects. The 12-inch pipe provides a 12-inch orifice, while simultaneously serving as a support for the antenna system. Each 1mm (.04 inch) of precipitation caught in an aluminum funnel assembly causes a tipping bucket to flip and a switch is monentarily activated. This causes an increment in an accumulator, brings the radio up to transmission power, and sends the station identifier and the rainfall accumulator value to the base station. At the base station, the time of receipt is added to the incoming message and filed in the computer data bank. Elapsed time for this entire procedure is less than two seconds.

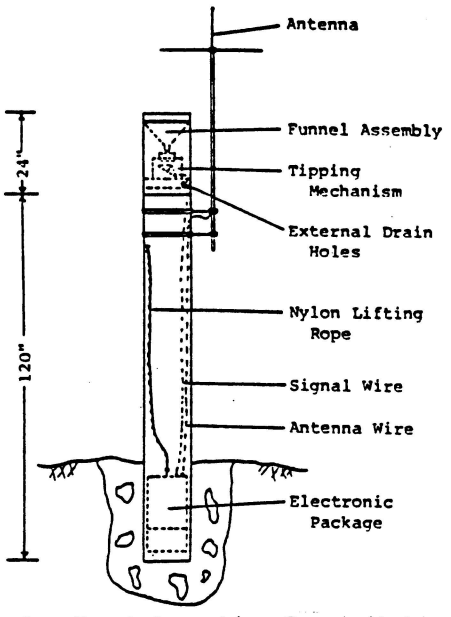

Figure 2. Event Reporting Precipitation Gage

The river gage is a simple event-reporting unit which transmits preselected incremental changes in river elevation. Where a stilling well is available, a float-type water level sensor is used. Other sensor types might include pressure transducers or bubbler gages. The same electronics and radio package used in the rain gage is utilized with the river gage. A river gage and precipitation tipping bucket mechanism may be collocated in the same structure and may share the same transmitter. Both are powered by self-contained batteries.

The radio transmitters in the precipitation gages and river gages are essentially identical. They are designed to transmit data in less than one-quarter of a second to minimize battery drain and reduce radio frequency interference. Due to the extremely short transmission time, over 100 transmitters, each reporting many parameters, can send messages on one frequency to one receiver without substantial loss of data.

The transmitter is enclosed in a weatherproof container which provides moisture protection for the electronics package. This container is designed to be below ground level inside the rain or river gage housing where it is protected from vandalism and kept at a relatively stable temperature. Also enclosed with the transmitter is the battery supply, which has the potential for powering over 25,000 data transmissions without recharging.

Repeaters can be used to receive and retransmit signals from a field transmitter to the base station when line-of-sight is not possible. The use of a repeater depends mainly on topography. A strategically located repeater can be used to receive signals from several sites on one frequency and retransmit them on the same or another frequency to the base station.

The base station of the ALERT system consists of an antenna and radio receiver for receipt of the event-reported radio signals, a micro-computer for collection and display of data, communications gear, and optional peripheral equipment. The base station operates continuously in a fully automatic mode, receiving data and processing information for display or warning to the user. The ALERT micro-computer is the "heart" of the monitoring system. With great ease and efficiency, the computer performs the monumental task of simultaneously coordinating hundreds or thousands of data reports, answering user questions, and communicating with remote computers. A number of different software packages are available by the NWS and private vendors for use on the base station computer. They can display data and maps, sound an alarm, assist in preparation of forecasts and warnings, disseminate information to other locations, and perform other useful tasks. The Sacramento streamflow simulation model can be used to provide updated streamflow forecasts every 5 minutes. Output from the hydrologic simulation model provides the local agency with a best estimate as to the severity of flooding. With this guidance, the local agency can take the necessary actions.

Southeastern Sites

A large number of ALERT type automated real-time data collection systems have been installed across the United States over the past few years but none have been in Georgia. Nearest systems are in Mt. Airy, NC; Lake Apopka, FL; and Hattiesburg, MS. Development is underway for systems in Roanoke, VA; in the St. Johns River Basin in Fl.: and at Meridian and Laurel, MS.

At Mt. Airy, North Carolina, the ALERT system consists of six rain gages and one river gage with a base station. The data is repeated to the nearest NWS office in Greensboro. This system is used for flood warning purposes as local officials must install stoplogs in a levee opening for rising river situations.

In Hattiesburg, Mississippi, the ALERT system is also used for flood warning purposes and consists of six rainfall gages, three combination rain/river gages, one repeater, and the base station. Both the Mt. Airy and Hattiesburg systems were installed as part of Corps of Engineers channel improvement projects.

The ALERT system for Lake Apopka, Florida is owned and maintained by the St. Johns River Water Management District. The lake is highly polluted and a complete water budget study is being conducted to determine the feasibility of pollution removal. The system is composed of 130 sensors in and around the lake measuring stage, flow, pump settings, ground water, wind, precipitation, temperature, humidity, solar radiation, evaporation, barometric pressure, conductivity, wave height, and gate or culvert openings.

ALERT systems are also being used to build data bases for long term studies and for water system management, dam safety and reservoir management, monitoring current weather conditions, pump monitoring, and to help calibrate weather radars.

NWS Involvement

Recognizing the importance of automated real-time data collection systems in improving flood warning service to communities, the NWS provides technical assistance to communities and government agencies to the extent resources are available. This support includes:

- assisting in identification of needed equipment for the systems,
- providing standards for automated local flood warning systems,
- assisting in site selection of hydrologic gages,
- obtaining FCC approval for necessary radio frequencies and licenses,
- coordinating activities of automated flood warning systems with city, county, state, and federal disaster officials,
- and providing training on the NWS flood and flash flood watch/warning program, the need for emergency response planning, operation and the maintenance procedure for the communication and hydrologic equipment, and periodic drills to test the program.

CONCLUSION

In the past decade, a substantial growth in technology and a decrease in the cost of computer systems have resulted in the development of automated data collection and flood warning systems. There are many private vendors now marketing automated local flood warning systems. The NWS encourages communities and government agencies to consider ALERT systems in projects related to mitigation of flood damages, and will provide technical support to those considering these systems.

ALERT is not designed to prevent flooding but to provide lead time to local officials during impending floods. This interpretation provides the opportunity to mitigate the loss of life and property associated with periods of flooding.

The role of the NWS is to assist local, state, or Federal entities in acquiring effective flood warning systems. ALERT systems are also being used for creating scientific data bases for a wide range of applications.

LITERATURE CITED

Burnash, R. J. C., 1982. Real-Time Rainfall-Runoff Forecasting - Today's Technological Revolution in Flood Protection.

Gimmestad, B. L., and C. Barrett, 1986. The ALERT Handbook.

National Weather Service, Western Region, 1981. Automated Local Evaluation in Real Time.